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The AMERICAN JOURNAL of OPTOMETRY

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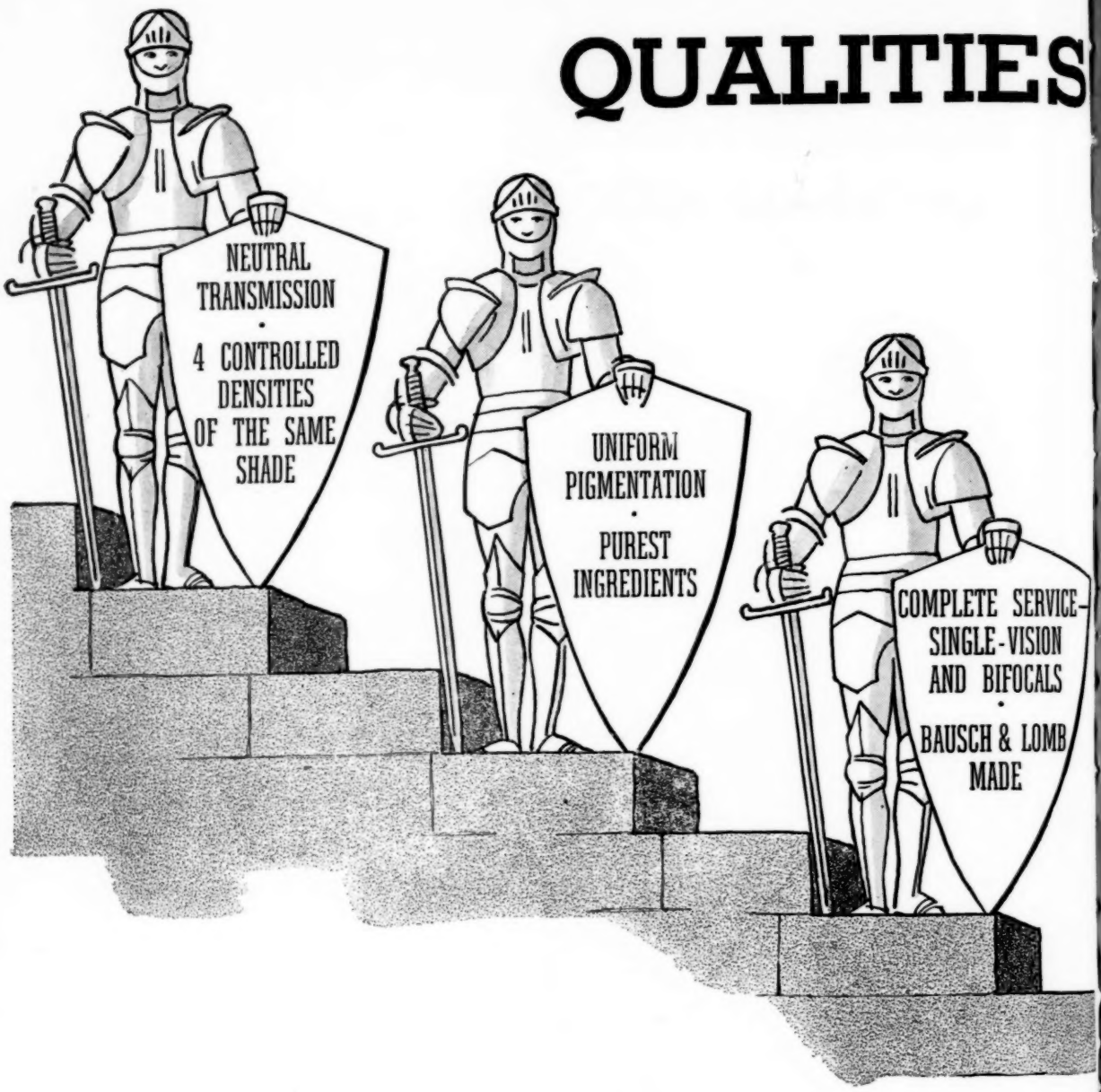

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AMERICAN JOURNAL OF OPTOMETRY

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THE PRINCIPLES and PRACTICE
of
OCULAR PHYSICAL THERAPY
for
OPTOMETRISTS
by
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OFF TO A "RUNNING START" WITH

AMERICAN JOURNAL OF OPTOMETRY

Vol. 13 SEPTEMBER, 1936 No. 9

AN INVESTIGATION OF THE VISUAL EFFICIENCIES OF 10,000 SCHOOL CHILDREN AND THE CORRELATION OF VISION AND SCHOLARSHIP*

Conducted by The Optometric Research Institute of Michigan
Ray Morse-Peckham, Director of Research

PRELIMINARY REPORT

The Problem

The investigation was undertaken in order to obtain information concerning seven major items: (1) Is there an increase of myopia (near sightedness) during successive years of school life or is the proportion of myopes in the upper grades about the same as in the lower grades? (2) If there is found a definite increase in the number of myopes year after year, can we gather definite prognostic signs of visual or eye measurement characteristics by which those susceptible to myopia can be recognized in the first stages? (3) Are girls or boys more susceptible to myopia? (4) Is there a valid basis for the assertion that poor school room illumination is largely responsible for the onset of myopia? (5) Is there a general decrease in visual efficiency, or a definitely general increase in visual inefficiency, during the school life of a noteworthy proportion of pupils? (6) Is there a statistical relation between visual efficiency and good scholarship, or between poor vision and poor scholarship, such as would be shown in the study of the visual efficiencies and student abilities of a large number of pupils? (7) Is there a definite relation between good eyesight and fast reading? Does poor eyesight of itself, or do certain refractive anomalies of themselves, tend to retard reading speed?

This is a pretty broad program and we might be justly criticized for undertaking so much. On the other hand, during a thorough survey it would be as easy to collect all that data as to collect any part; a proper answer to any one of the first five questions would necessarily include the investigation of the first, fourth and fifth and an answer to the second and third would be found in the data collected for the other three, if the examinations were thorough; the information needed for the second question is the most constructive item of all. In the material collected for

*Submitted for publication August 8, 1936.

the first five items would be found the needful material for the last two; and in the last two are the most valid reasons for the survey from the standpoint of educators and tax payers.

It is obvious that none of these questions could be satisfactorily answered by the study of a few pupils nor of a selected group. It is also plain that as to the first six questions no true answer could be found in a single survey, but that the same large group of children must be examined annually over a period of years. Accordingly, this program was planned for the annual examination of the same 10,000 pupils, or more if possible, for at least five years.

This is the first time in the history of education, so far as we can learn, that an investigation of this scope has been undertaken. It is a problem particularly optometric.

Although many visual school surveys have been made by groups of optometrists during the past decade, the published reports merely catalog the numbers in different types of refractive errors found. In none of these survey reports we have seen have there been grade by grade comparisons of findings, nor an attempt to correlate the visual findings with the scholarship ratings. Yet this seems to us as the only logical reason for school vision surveys. From the scientific point of view we have no interest in the number or kind of lenses that might be needed by a group of school children unless we know from actual investigation that the supply of such lenses will improve the scholarship of those with visual defects. We must further know which types of defects handicap scholastic effort and which types do not before we are warranted in insisting that school children must be provided with eyeglasses. Up to the present, the insistence that children with defective vision are thereby prevented from full advantage of the educational facilities of the schools has been solely from sentimental reasoning. The first step toward instructing the school authorities and the public as to the need for visual corrections for the pupils of the public schools must be the statistical proof that there is a relation between poor vision and poor scholarship. It is Optometry's duty to itself and to the state that has licensed its practice to make this contribution to the study of educational problems and further, it is Optometry's duty to make this investigation and this contribution to the world's knowledge because its members are better qualified than any other group to perform this task.

It is surprising how little real data exist on any of these subjects. Ask the average practitioner if he knows whether or not myopia increases during school life and he will answer according to his personal prejudices, perhaps giving some weight to the fact that quite frequently he runs into the case of the myopic child who says he or she could see the blackboard quite plainly until a year or two ago—which cannot be considered as conclusive evidence.

As to the first signs of myopia, many different theories have been advanced as to the causation of myopia and its early symptoms, but we have no actual data as to first signs.

As to the relation of vision to scholarship, again personal prejudice enters, since there is no reference in literature to an actual investigation. Some educators will tell you, "Why, we have known for years that there is such a relation." But they can only quote a few isolated instances of improvement in scholarship following the correction of very poor vision by spectacles. Others will say they doubt if there is a factual correlation and can cite innumerable cases of high scholarship in pupils with very poor vision. But no one has bothered to make a determinative investigation, using a large number of subjects of all school grades and of all social classes. Yet a certain amount of data has been available for many years. Sight testing of a sort has been carried on in most city schools for twenty years or more so that there are millions of distant vision records. Even this inadequate material could have been used in establishing some sort of experimental correlation.

As to the problem of visual efficiency and reading, considerable investigation has been carried on by psychologists, many of whom have a rather better understanding of visual efficiency than has the average ophthalmologist or optometrist. Most of these investigations were of small and selected groups of college or high school pupils. An excellent summary of these is presented by Brant Clark, "The Importance of the Correction of Ocular Defects in a Remedial Reading Program," in the May, 1935, issue of *The American Journal of Optometry*. Still, we feel that a record of a large number of children of all ages and school grades might afford a substantial contribution.

CLINICAL MATERIAL

This year 10,480 pupils were examined, from the first to the twelfth grades, in 13 different schools. The schools were selected to give us a broad cross-section of different social strata. In one of the schools the majority of the children were from well-to-do families, mostly living in city apartments in the better part of the city. Four of the schools were in prosperous residential suburbs, most of the families living in detached homes; in these schools were represented families ranging from the professional and upper merchant classes with adequate incomes and more or less cultured background down through the small tradesmen, clerical groups and skilled artisans to families in the unskilled labor class with small incomes. One of the schools was in a part of the city where most of the parents and some of the children were foreign born, the majority of Polish and Italian descent. Four of the schools were in a suburb where the fathers are nearly all of the unskilled labor class and nearly all the families are "On the Welfare." The other three schools were in different sections of the city and represented families of great variety of birth, cultural background and incomes,

but were mostly middle class city families of the skilled labor, small tradesmen and clerical groups; in the largest of these three, the majority of the children were second and third generation Irish, German and French-Canadian stock. In two of the suburbs most of the families had moved to Detroit from upper tier Southern States and might be classed as of "American" stock of originally English origin. In all, we feel that the selection includes all the variations of birth, family breeding and cultural background found in the average city.

One of the most outstanding features of the findings is the small proportion of defective vision in the schools where the majority of the children come from homes with steady and substantial incomes as compared with the amazingly high porportion of defective vision, particularly of cases with high astigmatism, in the schools where the children come from poverty stricken homes.

Percentages of myopes varied greatly in different schools, the smallest percentage being in the school where the children came from well-to-do homes; the next smallest percentage from the school where most of the children were of first generation Italian and Polish parentage; the highest percentage in the school where the majority of the children were of Irish, German and French-Canadian stock. Proportion of myopes in different grades varied greatly in different schools.

THE TESTS

Right at the start we are confronted with the question, What constitutes visual efficiency? There is no well established standard. Eyesight testing is based on the assumption that the ability to recognize a black line on a white background, at 20 feet, this line being of such width that it establishes a visual angle of 1′ at the nodal point of the eye, represents "normal visual acuity." But this takes into no consideration such factors as the degree of illumination, the width of the illuminated area, the surroundings of the illuminated area, all of which have been shown to affect the acuity. Still further, it has been found that acuity varies with distance, so why the standard 20 feet?

It is assumed that there should be "binocular vision," but no tests of binocular vision are used in general office practice, nor are tests of binocular vision included in the procedures taught in schools of optometry and ophthalmology, nor are any binocular tests included in the various "Standard Routine Examination Procedures" promulgated from time to time. Only by a considerable stretching of the imagination can phoria and duction tests be considered as tests of binocular vision or binocular efficiency.

Further, tests of visual "acuity" at the near work distance are entirely omitted in office practice and in all schedules of refractive examination procedures excepting for cases of presbyopia. We know of no reason for assuming that because the vision at 20 feet is of a certain grade, the vision at near of any person under 40 years of age must

necessarily be equal, nor for assuming that a correction satisfactory for distance vision must therefore be satisfactory for near vision simply because the individual is not yet 40 years old. In modern industrial life near work visual efficiency is more essential in most trades than excellent distance vision. Any practitioner, if he will trouble to make near vision tests of all patients, will find many a person where the 20/20 giving distance correction will not be adequate for near work.

As for the work of school children, if vision is any factor at all, near work vision is certainly important in the upper grades where most of the work is book study and written papers. In our examinations of school children, we found many with fairly good distant vision but with very poor near vision. Our findings show that many hyperopes with 100% distance vision have only 50% or 60% near work vision at 14 inches. The work of all who have investigated reading ability in either adults or children shows that the binocular efficiency is a strong factor in the speed of reading.

Yet in all the years of eyesight testing of school children, which has been largely under the dominance of the medical profession, tests of near vision and binocular tests have been utterly ignored.

In all the years of refraction by oculists and optometrists, near vision and binocular vision have been utterly ignored save by a very few. This was brought home to us while training our examining staff for this school survey—not one had the habit of making near vision tests of children in his office practice and most had more or less difficulty in perceiving the need of and the meaning of binocular tests. Most thought phoria and duction tests were tests of binocular visual efficiency.

Thus, lacking any standard of what constitutes normal visual efficiency, we were forced to pioneer and set up an experimental set of tests which could be relied upon to discover the greater instances of visual inefficiency and which to some degree would enable us to classify the subjects in terms of relative efficiencies. These tests and the methods of making tests and the apparatus used were modified as experience taught us improvements and will be still more modified when we start work in the schools this fall. We shall not take the space necessary for a full description of tests at this time. In a later paper we shall describe and discuss each in full.

Following are the tests used, with brief notes of changes we shall incorporate this year. Apparatus and methods are uniform in all schools. Illumination was fixed at 30 c.p. for all tests.

(1) Letter vision at 20 feet, monocularly and binocularly, for all pupils from third to twelfth grades, using Wiseman's arrangement of Snellen letters. Distant vision for first and second grades was measured by the Bailey Visual Perception Test at 10 feet. Next year the tests for the third and fourth grades will be made with special test charts of words instead of letters, which we are now constructing. This will be

better, since in these grades only the children with home training are familiar with letters but are taught words in the school system.

(2) Letter Vision at 14 inches, monocular and binocular. The charts are reduced Snellen Letter Charts. This test was omitted in the first, second and third grades. Special near test charts are now in preparation for use in these grades next season.

(3) Stereoscopic Vision at 20 feet, using a test devised by Robert H. Peckham several years ago. This definitely shows if subject uses both eyes or if one eye is suppressed.

(4) Fusion and fixation at 14 inches, using the Peckham F-L-E test in an isosceles prism stereoscope designed at The Optometric Research Institute. This test chart is so made that targets for testing foveal fusion and fixation are separate from the targets for peripheral fusion. Ordinary Holmes-Brewster type stereoscopes are useless for these tests, since accommodation and convergence are both interfered with by the plus spheres and normal inter-relations are disrupted.

(5) Bar-reading test to determine if the basic binocular functions of retinal rivalry and binocular projection of monocular images are established and if the pupil habitually uses both eyes in reading.

(6) Monocular Skiametry, to determine the ciliary tonicity of each eye for comparison with vision at both 20 feet and 14 inches and for determining the number of myopes and hyperopes and the number of astigmatic cases. We are hoping that the method used will assist in picking out the signs of incipient myopia. This can only be determined by the work of several years and the comparisons of findings from year to year for each child.

(7) Ophthalmometry. This had to be discontinued after a few hundred pupils had been examined because of the time required. But as skiametric records indicate that astigmatism is more common in upper grades than in the lower grades, we feel that some way must be found to include accurate corneal measurements and records made of changing or constant curvatures from year to year for each pupil.

(8) Handedness and Hand-and-Eye Pointing. Records were made of 900 pupils to find if there were shown any correlation between this and reading rate. No form of relation was shown, so this test was dropped.

(9) Entry of pupil's vision in previous years, where such records appeared on the school card.

(10) Record of juvenile cataracts, corneal scars, opacities, pathological signs, strabismus or other noteworthy anomalies.

(11) Record of glasses worn if any, and record of vision both with and without; record as to whether present glasses are adequate or inadequate.

(12) Age of pupil in years and months.

(13) Record by teacher as to whether pupil is fast or slow reader.

(14) Pupil's rating in reading test, based on reading speed and comprehension. (This was not available in all schools but has been promised by all for next year's records.)

(15) Pupil's Grade Level in Reading, when available.

(16) Pupil's Scholarship Rating. As different marking methods are employed in different schools, principals agreed on following method of rating:

A Students. Those showing exceptional ability and originality.

B Students. Those whose marks are above average but not showing the originality and exceptional brilliance of the A Students.

C Students. Average. Those who always pass but show no outstanding ability. Graded as "Satisfactory" in some schools. Earning marks averaging about 80% to 85% where percentage systems are still used.

D Students. Below average, not satisfactory, often failing in class work and examinations.

E Students. Consistent "Repeaters," failures in all subjects.

In tabulating records, D and E students have been grouped together. As the separation of A and B students is somewhat difficult, with minor shadings, perhaps influenced by the teacher's personal view, it may be better to put all above average pupils in a single group.

(17) I. Q. Ratings. Not available in all schools. In one group of four schools, the superintendent became so much interested in the survey that he had the I. Q. tests made especially for this purpose. Different I. Q. tests are used in different schools, but it is doubtful if this variance would have a statistical meaning in this survey.

THE SLOW READING PROBLEM AND SUPPLEMENTAL VISUAL STUDIES

That visual efficiency or inefficiency is but part of the total problem of reading efficiency or inefficiency may be readily conceded. But the relative value of that part has not yet been determined, since it is but recently that educators themselves have considered it and since those most able to assist the educators, namely, ophthalmologists and optometrists, have not come forward with an offer of co-operation.

In the phrase "Visual Efficiency" we must include binocular efficiency and near work vision as well as visual acuity at distance.

In 1931, after several years of clinical study of the reading difficulties of both adults and children met in the routine of office practice, I suggested that perhaps binocular inefficiency, in the form of inexact fixation and intermittent suppressions, might be fully as much a handicap in reading as poor vision and proposed this as a good subject for laboratory research. I tried to persuade one of the Teachers' Colleges, whose head had consulted with me on this problem, to undertake a

research investigation of the subject, but the idea was negatived by a physician on the staff who opposed it merely because it was suggested by an optometrist. This was in keeping with the general attitude of the medical world toward the visual problems of the school child; they will do nothing themselves and they will not let anyone else do anything.

However, I have succeeded, in various roundabout ways, in awakening interest in various places and considerable work has been done. The results confirm my earlier postulate.

Further, during the past few years very important work has been done in various psychological loboratories and much of the material published bears out this view of the relative importance of accurate and simultaneous bifoveal fixation in all visual work.

Fast reading is a matter of few fixations per line; the slow reader makes many fixations per line. This has been shown by innumerable objective studies of eye movements, most of which also show that inaccuracies of fixations are closely associated with slow reading. I have found that correction of refractive errors not only increases sharpness of vision but reduces inaccuracies of fixation and reduces the number of fixations per line. This may be due to the two factors of increased acuity and reduction of focusing effort.

Eye exercising increases the speed of reading by increasing the accuracy of fixation and so reducing the number of fixations per line. In many instances eye exercising without the refractive errors being corrected increases speed of reading. As to whether this is a temporary improvement and lasts only so long as the exercises are kept up has not been determined. On the other hand, full correction of the refractive error and of the accommodative deficiency for near work permanently increases speed of reading and comprehension without resort to eye exercising save in a few instances of important anisophorias which do not disappear when lenses are supplied. These are my experiences in office practice. This would be a proper subject for laboratory investigation and I hope some one will take up this phase of the problem in the near future.

However, binocular inefficienecy, as demonstrated in the findings of important anisophorias and inexact fixations, may be and often is present without refractive errors. In many instances efficiency is established by proper eye exercising, but we do not yet know how permanent the improvements are. Nor do we know the details of the sources of these forms of binocular inefficiencies. Nor do we yet know which cases are proper subjects for eye exercises and which cases will not respond. Orthoptics are no catholicon, despite the enthusiasm of some protagonists.

Since the factor of inaccurate fixation as a handicap to reading has already been established; since there is evidence that correction of refractive errors, particularly of hyperopia and high astigmatism, reduces inaccuracies of fixation; since the relation of poor vision as a factor in

slow reading has not been definitely established, it seemed to us that this first year's survey could be well narrowed down to a study of the association of poor vision with slow reading, as would be shown by comparing the number of fast and slow readers with good vision with the number of fast and slow readers with poor vision and comparing the number of fast and slow readers with various refractive errors with the number of fast and slow readers without refractive errors.

Therefore, we did not include special tests for accuracy of fixation in the first year's program. As to recording number of fixations per line, this, in view of work already done, is not a matter of importance. For the number of fixations per line is only a symptom. It is not a primary cause of slow reading, but is only the end result of handicaps to fixation insofar as it is a part of the visual phase of the slow reading problem. The number of fixations per line is not a part of the diagnosis of the slow reader's problem.

The width of the field of clear perception is a part of the reading problem. It is self evident that the owner of a pair of eyes giving unblurred vision of a group of words occupying two inches or more will be a faster reader than one whose eyes only encompass a clear view of an inch of type, for he will need fewer fixations per line. This phase is closely related to the refractive error or freedom from error of the eye, at least in many cases and perhaps in the majority. Yet, it is also a matter of mental maturation and intelligence. The point is to find the proportion of each, if possible. At least we can discover how much the field of clear vision is improved by corrections of refractive errors and the supply of assistance when there is deficient accommodation. I might add here that we have found, during our work in orthoptic training at The Optometric Research Institute, that in some cases the width of the field of clear vision can be increased by properly directed training.

Therefore, in a problem with so many complexities, few of which have undergone exhaustive study, it seemed to us that it would be wiser to only include in the first year's survey such tests as would disclose the grosser forms of visual handicaps and find if these had any statistical relation to the scholarship abilities of the pupils. Further, if we were to refine our tests for this first survey and include all that seemed desirable, so much time would be taken for each pupil that it would be impossible to make a survey of a large number. There have been a great many detailed investigations of small groups, but no data has been collected and collated on large groups. If this survey should show a definite correlation between vision and scholarship in a large body of students of all ages and social backgrounds, then there would be reason for detailed investigation of various phases of visual handicaps. After such a detailed investigation we would be in better position to determine what additional tests should be included in a visual survey of school children.

A part of our program for next year (if we can find the money for the work) is to select groups with the same visual efficiencies and the same scholarship efficiencies; with the same visual deficiencies and the same scholarship deficiencies; with the same visual efficiencies and the same scholarship deficiencies; with the same visual deficiencies and the same scholarship efficiencies. Of course these groups must be made up of pupils of the same sex; of about the same age; of similar intelligence and maturation. Probably there would be twenty or more of these control groups. In each of these groups we shall make a detailed study of the visual attributes. This will lead to a further subdivision of the groups in terms of visual efficiencies. Perhaps out of this may develop a standard of visual efficiency, if the investigation is carried on for several years. During this period we would have the records of improvement in scholarship following correction of refractive errors.

MAJOR CLASSIFICATIONS OF VISUAL EFFICIENCIES

In our first classification of pupils, we divided them into three major groups according to their distant vision. We did this since the present general system of rating visual efficiency is in terms of monocular vision at 20 feet and we thus conform with general custom.

In Visual Group I are listed all those with 90% (20/22) or better distant vision with both eyes, who had 80% or better vision with both eyes at 14 inches and who promptly and unequivocally passed the three binocular tests.

In Visual Group II are listed those with between 80% (20/25) and 90% distant vision with both eyes; those with 80% with one eye and 90% or better with the other eye; those with less than 80% vision at 14 inches with one or both eyes even though they had better than 90% distant vision; those who failed on some of the binocular tests even though monocular vision with either eye was 90% or better at distance; and those whom we suspected of malingering even though the record was less than 70% distant vision.

In Visual Group III are listed those with 70% (20/30) vision and less at distance with both eyes; those with less than 70% vision with one eye even if the other eye's vision is 90% or better; in this group are those with 100% or better vision at 14 inches if the distance vision is less than 70%. Hence, this group includes nearly all the myopes, most of the hyperopes and most of the astigmatic cases.

This standard of 20/30 was adopted since it is the vision required in most of the Detroit factories and is the minimum acceptable vision for employees of the United States Civil Service.

This grouping is arbitrary, since, as we have pointed out, there is no standard as to what constitutes visual efficiency. Each group may be subdivided. For example, Group I may be subdivided into those with 100% vision at 14 inches and those with 80% to 100%; or by

the skiametric findings into those with emmetropic measurements, those showing a small amount of hyperopia, those with low negative accommodation (ciliary hypertonicity characteristic of latent hyperopia), those with minor amounts of astigmatism. The other groups, II and III, may be similarly subdivided into several sub-classes.

However, this three class grouping serves well for the first separation of the fairly efficient; the questionable cases that present the most outstanding phases of binocular inefficiencies; the definitely handicapped who need immediate attention.

Notices were sent to parents of all those listed in Group III, calling their attention to the definite handicap under which their children labor. We are interested in what will happen to the children in Group II, for in this group are the ones suspected of incipient myopia. We wonder how many of these will become definitely myopic during the next two or three years and if our proposed diagnostic method of picking the incipient myopes is correct.

If a pupil is wearing spectacles, when those lenses are found adequate the pupil is classed in Group I if he makes that rating with lenses. Similarly, those wearing glasses evidently not wholly adequate are classed in Group II or Group III according as they rate in tests with the glasses on. When the vision is poorer with glasses than without the child is classified according to his rating without lenses and the teacher is so notified. A number of pupils were wearing lenses with which they did not have stereoscopic vision although without them they passed all binocular tests.

Though 10,480 pupils were examined, 243 records were thrown out as incomplete or of doubtful accuracy. Tables 1 to 4 represent the visual findings of 5,036 girls and 5,201 boys, total 10,237.

As the visual efficiency of boys and girls is plainly comparable and different, as shown by the results of these tests, and as the sex differences in scholarship and reading ability have already been demonstrated in the educational field, we keep to separate analyses of boys and girls as being more useful than a single analysis of the entire group. Those who wish entire group averages can easily find them by adding the data given in these tables.

We were unable to obtain scholarship ratings and reading scores of all the pupils before school closed in early June, as our visual examinations continued through the last week of school. The tables of scholarship ratings include 3,102 girls and 3,188 boys, total 6,290. The tables of reading include 2,886 girls and 3,031 boys, total 5,917.

Since the collected data show many variables in each attribute, a great deal of detailed information may be collated. In the attributes of distance vision and near vision we may subdivide variables almost indefinitely. The skiametric findings are also capable of considerable subclassification. In the findings of the F-L-E fusion test there are 12 types

of answers. And so on. All this involves an immense amount of statistical work. When completed, proper weighting of each visual factor to the various scholarship variables will doubtless be shown and we shall find what visual factors are the more important.

As our first interest centers around the question as to whether there is or there is not a statistical relation between good vision and good scholarship, between visual handicaps and poor student ability, between good vision and fast reading, between slow reading and visual inefficiency, we shall first use simple manifold classifications of the larger subdivisions of the attributes of good or poor vision and good or poor scholarship and fast or slow reading. From this first classification we shall exclude the intelligence quota ratings, although the data show these are of decided relation to both vision and scholarship. If this system of classification shows important statistical correlations between vision and scholarship, then we shall have reason for detailed study of variables in order to find what type of visual problem most affects scholarship. Without doubt this would necessitate surveys of many more thousands of pupils. But if this first classification in the rough shows no definite correlation between vision and scholarship, there would be no particular advantage in pursuing the subject farther.

Accordingly, in this preliminary report, only the larger aspects of the problem are presented and only the larger groups are correlated. The tabulation is by double entry. The graphs submitted show proportions of each large Visual Group in each large Scholarship Group and the proportions of each large Scholarship Group in each Visual Group.

Table I. Showing the Tendency Toward Decrease in Visual Efficiency During Successive Years of School Life

Percentages of Pupils in Each Grade in Visual Group I, rated as Visually Efficient

	5.036 Girls		5.201 Boys	
Grade	No. of Pupils in the Grade	% Found Visually Efficient	No. of Pupils in the Grade	% Found Visually Efficient
1	440	52%	544	53%
2	480	52%	550	53%
3	505	43%	552	41%
4	554	37%	625	47%
5	535	36%	507	53%
6	502	36%	610	53%
7	512	39%	513	48%
8	477	40%	440	51%
9	331	38%	275	41%
10	240	47%	204	48%
11	218	47%	212	53%
12	242	47%	169	45%
Total	5,036	42%	5,201	49%

In studying these tables, note that with the eighth grade the number of pupils falls off sharply from year to year as children leave school and go to work. So from the eighth grade on these figures do not represent a cross-section of the vision of all boys and girls but only of those who remain in school.

Table II. Showing the Tendency Toward Increase of Visual Handicaps During the Successive Years of School Life

The number of pupils in each Grade is shown in Table I.

	5,036 Girls		5,201 Boys	
Grade	% Found with 20/30 Vision or Worse Group III	% Found with Minor Handicaps Group II	% Found with 20/30 Vision or Worse Group III	% Found with Minor Handicaps Group II
1	12%	36%	9%	38%
2	12%	36%	9%	38%
3	18%	39%	18%	41%
4	20%	43%	20%	38%
5	22%	41%	16%	31%
6	25%	39%	17%	30%
7	25%	36%	22%	30%
8	28%	32%	18%	31%
9	26%	34%	27%	32%
10	22%	41%	25%	37%
11	22%	31%	16%	31%
12	20%	33%	26%	27%
Total	21%	37%	17%	34%

From these tables we gather several interesting points. The proportion of girls with poor vision is much higher than the proportion of boys. There is shown a steady tendency toward decrease of good vision in girls and a steady increase of poor vision below 20/30 from grade to grade. But among the boys the curves of lessened visual efficiency from grade to grade are quite erratic. However the tendency of boys to drop to vision 20/30 or worse is quite steady from grade to grade.

We shall not tabulate here the changes in vision shown by comparing previous records of vision with this year's records, but there are many interesting features. Of those definitely now myopic, previous records in most cases show a year by year decrease in vision. But we find many records of poor vision two to five years previously where this year's records show very good vision. Inquiry showed that some of these pupils did have poor vision at one time, wore glasses for a while, then discarded them.

Considerably to our surprise, the skiametric findings show a year to year increase of astigmatism. So the year by year increase of pupils with 20/30 vision or worse is due to two factors: (1) the increase of myopia as shown in Table III; (2) the increase of astigmatism, which will be made the subject of a special report to be issued soon.

Table III. Showing the Grade by Grade Increase of Myopia in Group III; The Grade by Grade Increase in the Signs of Incipient Myopia in Group II; and the Year by Year Decrease of the Negative Accommodation in Group I.

The Number of Pupils in Each Grade is as in Table I.

	Group III % of Myopes with Vision 20/30 or Worse	Group II % of Pupils with Vision Between 20/22 and 20/30, the Skiametry Indicating Myopia or Myopic Tendency	Group I % of Pupils with Good Distance Vision, with Skiametric Findings Indicating Ciliary Hypertension
GIRLS			
Grades			
1 and 2	60%	59%	35%
3 and 4	66%	64%	56%
5 and 6	68%	68%	66%
7 and 8	77%	80%	66%
9 and 10	80%	80%	66%
11 and 12	75%	66%	52%
BOYS			
Grades			
1 and 2	52%	48%	38%
3 and 4	64%	63%	48%
5 and 6	61%	58%	58%
7 and 8	69%	68%	58%
9 and 10	86%	84%	75%
11 and 12	85%	63%	58%

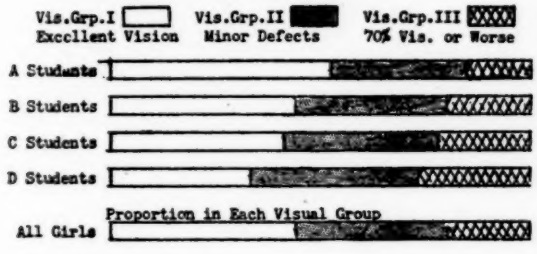
The noteworthy points here are: The percentage of myopes (Col. I) increases steadily year by year; there are more myopes among the girls than among the boys. In Col. II, the percentage of myopic suspects increases year by year at about the same rate as the increase of definite myopia. In Col. III, the increase of cases with low negative accommodation increases year by year at about the same rate as does definite myopia.

A better understanding of the meaning of this will be gained as we re-examine all these children year after year. What per cent of these subjects in Group I (Col. III) with low ability to "Relax the Accommodation" will be found in Group B with binocular inefficiencies or

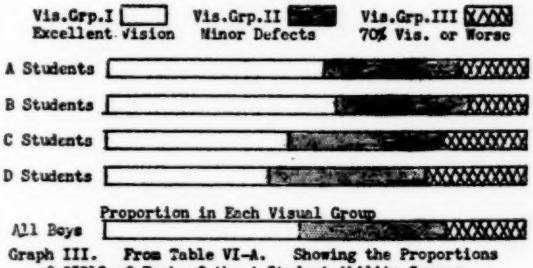
CORRELATIONS OF VISION AND SCHOLARSHIP

6290 PUPILS IN 12 GRADES

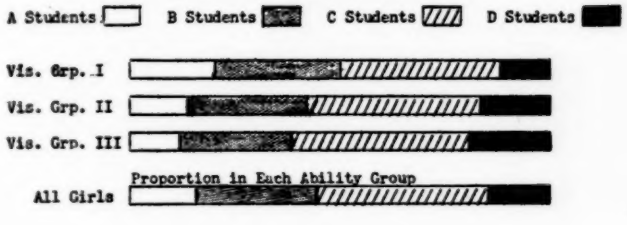
Graph I. From Table V-A. Showing the Proportions of GIRLS of Each of the 3 Visual Groups in Each of the 4 Student Ability Groups



Graph II. From Table V-B. Showing the Proportions of BOYS of Each of the 3 Visual Groups in Each of the 4 Student Ability Groups



Graph III. From Table VI-A. Showing the Proportions of GIRLS of Each of the 4 Student Ability Groups in Each of the 3 Visual Groups



Graph IV. From Table VI-B. Showing the Proportions of BOYS of Each of the 4 Student Ability Groups in Each of the 3 Visual Groups

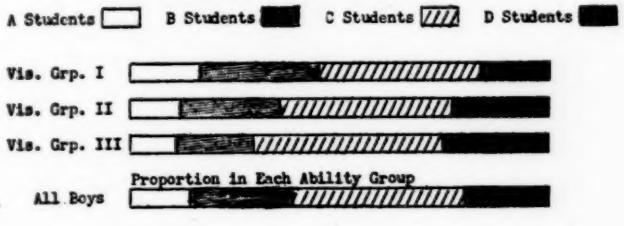


Table IV. The Proportion of Myopes with 20/30 Vision or Worse in 11 Different Schools with Varying Degrees of Illumination

School No.....	1	2	3	4	5	6	7	8	9	10	11	
Grades 1-3												
Lighting	Bad	Bad	Bad	Bad	Poor	Fair	Fair	Fair	Fair	Good	Good	Total
Number Pupils.....	500	118	638	436	203	250	468	131	140	231	200	3,315
Number Myopes.....	15	5	65	18	20	14	29	14	10	20	15	225
% Myopes	**3.0%**	**4.6%**	**10.0%**	**4.0%**	**10.0%**	**6.4%**	**6.5%**	**10.0%**	**7.0%**	**8.6%**	**7.5%**	**6.7%**
Grades 4-6												
Lighting	Bad	Bad	Bad	Poor	Poor	Fair	Fair	Good	Good	Good	Good	
Number Pupils.....	331	100	664	298	144	207	496	168	185	243	289	3,125
Number Myopes.....	34	21	134	32	29	16	32	27	10	17	55	407
% Myopes	**10.0%**	**20.0%**	**20.0%**	**11.0%**	**20.0%**	**7.7%**	**6.5%**	**16.0%**	**5.0%**	**7.0%**	**19.0%**	**13.0%**
Grades 7-9												
Lighting	Bad		Fair	Good		Good	Good	Good	Good	Good	Good	
Number Pupils.....	253		545	255		140	279	197	152	167	403	2,391
Number Myopes.....	32		133	39		21	46	31	22	20	71	415
% Myopes.....	**12.0%**		**24.0%**	**15.0%**		**15.0%**	**16.5%**	**15.7%**	**14.5%**	**12.0%**	**17.5%**	**17.3%**
Grades 10-12												
Lighting			Fair	Good		Good	Good	Good	Good	Good	Good	
Number Pupils.....			412	153			104	140	66		170	1,045
Number Myopes.....			74	29			21	14	14		40	192
% Myopes.....			**18.0%**	**19.0%**			**20.0%**	**10.0%**	**21.0%**		**23.5%**	**18.4%**
Totals, 6 Primary Grades in 11 Schools												
Number Pupils.....	831	218	1,302	734	347	457	964	299	325	474	489	6,440
Number Myopes.....	49	26	199	50	49	30	61	41	20	37	70	632
% Myopes.....	**6.0%**	**12.0%**	**15.0%**	**6.8%**	**14.0%**	**6.5%**	**6.5%**	**13.7%**	**6.0%**	**8.0%**	**14.3%**	**9.8%**
Totals, 9 Primary and Intermediate Grades in 9 Schools												
Number Pupils.....	1,084		1,847	989		597	1,243	496	477	641	892	8,266
Number Myopes.....	81		332	89		51	107	72	42	57	141	972
% Myopes.....	**8.0%**		**18.0%**	**9.0%**		**8.0%**	**8.8%**	**14.5%**	**8.7%**	**8.9%**	**15.8%**	**11.7%**
Totals, 12 Primary, Intermediate and High School Grades in 6 Schools												
Number Pupils.....			2,259	1,142			1,347	636	543		1,062	6,989
Number Myopes.....			406	118			128	86	56		181	975
% Myopes.....			**18.0%**	**9.0%**			**9.5%**	**13.5%**	**10.0%**		**17.0%**	**14.–%**
Averages, All Schools												
% Myopes.....	**8.0%**	**12.0%**	**18.0%**	**9.0%**	**14.0%**	**8.0%**	**9.5%**	**13.5%**	**10.0%**	**8.9%**	**17.0%**	**12.5%**
											Total Number of Myopes	1,239
											Total Number of Pupils	9,876

NOTE: As there is no authoritative standard for school room illumination, lighting in this table is rated as Good, Fair, Poor, Bad by comparison of illumination in these schools at different hours and in various weathers, as follows:

GOOD—High wide windows at side of room, giving good spread; shades well arranged to break down and distribute direct sunlight; light at no desk less than 25 c.p. at any hour of clear days; artificial lighting giving not less than 15 c.p. at any desk on dark winter days.

FAIR—Not less than 15 c.p. at any desk on clear days when sun is on opposite side of building; artificial illumination giving not less than 10 c.p. at any desk on dark winter days.

POOR—Uneven illumination at all hours in day time; on clear days desks farthest from windows not receiving less than 10 c.p.; on gloomy winter days with all lamps lighted desks receiving from 5 c.p. to 10 c.p.

BAD—Uneven illumination at all times; during parts of the day on clear days the desks farthest from windows receiving 4 c.p. to 8 c.p.; on gloomy winter days with all lamps lighted no desk receiving as much as 5 c.p.

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reduced distance vision during the next five years? What per cent of those in Group II (Col. II) will next year or the year thereafter be found in Group III with 20/30 vision or less?

Another tabulation of myopes will be made by ages. Then a comparison of the grade by grade increase with year by year age increase may throw more light on this steady increase of myopia.

Preventive Optometry. If anything can be done, by any method, to save these children from becoming myopes or from increasing myopia, Optometry has an opportunity to show a reason for its existence. If funds were available, we should like to select control groups and see what could be done. But the writer is of the opinion that it will be just as interesting and just as valuable to wait for subsequent examinations of these same groups and see what happens.

Inspection of the data shows no statistical association between poor schoolroom lighting and the development of myopia. However, this does not preclude such an association in an occasional individual case.

Table V-A. Numbers and Percentages of Each of the Four Student Ability Groups in Each of the Three Visual Groups of 3,102 Girls

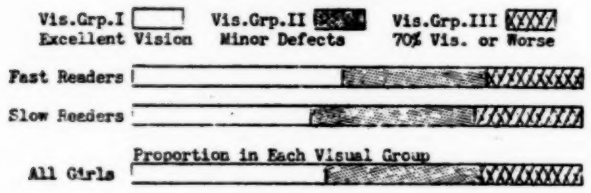
Number and Percentage of Girls in Each Ability Group	Visual Group I	Visual Group II	Visual Group III	
A Students 497— 16%	259—52%	163—33%	75—15%	(100%)
B Students 879— 28%	396—44%	314—36%	169—20%	(100%)
C Students 1253— 41%	516—41%	458—37%	279—22%	(100%)
D Students 473— 15%	155—33%	186—40%	132—27%	(100%)
Total Girls 3102—100%	Division by Visual Groups 1326—43%	1121—36%	655—21%	(100%)

Refer to Graph I.

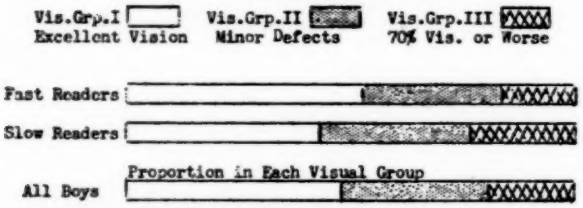
CORRELATIONS OF VISION AND READING ABILITY

5917 PUPILS - GRADES 3 TO 12

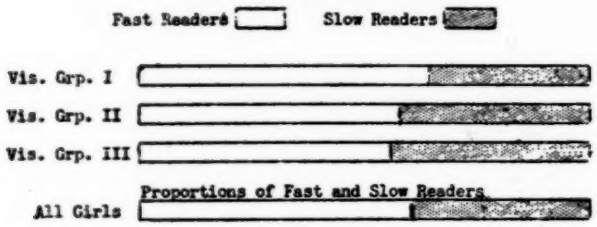
Graph V. From Table VII-A. Showing the Proportions of GIRLS of Each of the 3 Visual Groups in the Fast and Slow Reader Groups



Graph VI. From Table VII-B. Showing the Proportions of BOYS of Each of the 3 Visual Groups in the Fast and Slow Reader Groups



Graph VII. From Table VIII-A. Showing the Proportions of GIRLS Who are Fast or Slow Readers in Each of the 3 Visual Groups



Graph VIII. From Table VIII-B. Showing the Proportions of BOYS Who Are Fast or Slow Readers in Each of the 3 Visual Groups

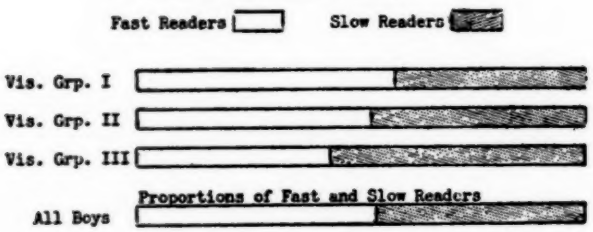


Table V-B. Numbers and Percentages of Each of the Four Student Ability Groups in Each of the Three Visual Groups of 3,188 Boys

Number and Percentage of Boys in Each Ability Group	I	II	III	
A Students 446— 14%	237—51%	140—32%	69—17%	(100%)
B Students 777— 24%	416—54%	252—32%	109—14%	(100%)
C Students 1298— 41%	564—43%	473—37%	261—20%	(100%)
D Students 667— 21%	255—38%	255—38%	157—24%	(100%)
	Division by Visual Groups			
Total Boys 3188—100%	1472—46% Visual Group	1120—35% Visual Group	596—19% Visual Group	(100%)

Refer to Graph II.

Table VI-A. Numbers and Percentages of Each of the Three Visual Groups in Each of the Four Student Ability Groups of 3,102 Girls

Number and Percentage of Girls in Each Visual Group	Ability Group A	Ability Group B	Ability Group C	Ability Group D	
Visual Group I 1326— 43%	259—19%	396—30%	516—39%	155—12%	(100%)
Visual Group II 1121— 36%	163—14%	314—28%	458—41%	279—17%	(100%)
Visual Group III 655— 21%	75—11%	169—26%	279—43%	132—20%	(100%)
	Division by Student Ability				
Total Girls 3102—100%	497—16%	879—28%	1253—41%	473—15%	(100%)

Refer to Graph III.

Table VI-B. Numbers and Percentages of Each of the Three Visual Groups in Each of the Four Student Ability Groups of 3,188 Boys

Number and Percentage of Boys in Each Visual Group	Ability Group A	Ability Group B	Ability Group C	Ability Group D	
Visual Group I 1472— 46%	237—16%	416—28%	564—39%	255—17%	(100%)
Visual Group II 1120— 35%	140—12%	252—23%	473—42%	255—23%	(100%)
Visual Group III 596— 19%	69—11%	109—18%	261—45%	157—26%	(100%)
	Division by Student Ability				
Total Boys 3188—100%	446—14%	777—24%	1298—41%	667—21%	(100%)

Refer to Graph IV.

Studying Tables V-A and V-B the striking correlations between vision and scholarship are rather overwhelming. Reading across the top line of both tables, we see that 52% of the A students among the girls and 51% of the A students among the boys have excellent vision and binocular efficiency while only 15% and 17% respectively of the A students are seriously visually handicapped.

Studying the vertical columns under the Visual Groupings, we are impressed by the showing. In the first columns (those who are highly efficient visually) if we read upwards we perceive the heavy factor of good vision in producing good students. Reading down the last columns, we note the almost double percentage of D students over that of A students among the seriously handicapped.

Throughout there is less statistical difference between the B and C students in each Visual Group than between the A and B students and between the C and D students.

In Tables VI-A and VI-2, reading the vertical columns downward, we see that the proportions of A and B students decrease with

Table VII-A. Number and Percentages of Fast and Slow Readers in Each of the Three Visual Groups of 2,886 Girls

Number and Percentages of Girls in the Two Groupings of Reading Ability	Visual Group I	Visual Group II	Visual Group III	
Fast Readers 1739— 60%	799—46%	579—33%	361—21%	(100%)
Slow Readers 1147— 40%	443—39%	428—37%	276—24%	(100%)
Total Pupils	Division by Visual Groups			
2886—100%	1242—43%	1007—35%	637—22%	(100%)

Refer to Graph V.

Table VII-B. Number and Percentages of Fast and Slow Readers in Each of the Three Visual Groups of 3,031 Boys

Number and Percentages of Boys in the Two Groupings of Reading Ability	Visual Group I	Visual Group II	Visual Group III	
Fast Readers 1615— 53%	838—52%	530—32%	247—16%	(100%)
Slow Readers 1416— 47%	608—43%	483—34%	325—23%	(100%)
Total Boys	Division by Visual Groups			
3031—100%	1446—48%	1013—33%	572—19%	(100%)

Refer to Graph VI.

Table VIII-A. Number and Percentages of Each Visual Group Among the Fast and Slow Readers of 2,886 Girls

Numbers and Percentages of Girls in the Three Visual Groups	Fast Readers	Slow Readers	
Visual Group I 1242—43%	799—64%	443—36%	(100%)
Visual Group II 1007—35%	579—57.5%	428—42.5%	(100%)
Visual Group III 637—22%	361—56%	276—44%	(100%)
Total Pupils 2886—100%	Division by Reading Ability 1739—60%	1147—40%	(100%)

Refer to Graph VII.

Table VIII-B. Number and Percentages of Each Visual Group Among the Fast and Slow Readers of 3,031 Boys

Numbers and Percentages of Boys in the Three Visual Groups	Fast Readers	Slow Readers	
Visual Group I 1446—48%	838—57%	608—43%	(100%)
Visual Group II 1013—33%	530—52%	483—48%	(100%)
Visual Group III 572—19%	247—43%	325—57%	(100%)
Total Boys 3031—100%	Division by Reading Ability 1615—53%	1416—47%	(100%)

Refer to Graph VIII.

increased visual handicaps, the proportion of A students decreasing more rapidly than the proportion of B students. We also perceive that the proportion of C and D students increases with increase of visual handicaps, the proportion of D students increasing more rapidly with visual handicaps than the proportion of C students.

From these tables we learn that there is an important statistical correlation between visual defects and reading ability. This interpretation is perhaps strengthened since the fast and slow readers are numerically about even. The influence of poor vision in handicapping reading is more apparent in the study of the fast readers than in the comparison of the groups of slow readers.

Reading across the first lines of Tables VII-A and VII-B, we note the rapid decrease of fast readers with decrease in visual efficiency. If we read the vertical columns of these tables, we see that there are notably more visually efficient fast readers than there are visually efficient slow readers and there are notably more slow readers with heavy visual handicaps than there are fast readers with the same degree of visual handicap. Fast and slow readers are about equal in the group with minor visual handicaps.

Inspecting Tables VIII-A and VIII-B, the associations stand out even more noticeably. Reading vertically, we find that fast reading decreases rapidly with decreasing vision and slow reading increases rapidly with decreasing vision.

THE EFFECTS OF POOR VISION

It must be remembered that this collation of the data is based on the distant vision. Both scholarship rating and reading scores are affected adversely by poor vision. It is shown that the effect of poor vision is proportionate to its poorness, that is, inspection shows that, even with this rough classification, the poorer the vision the poorer the scholarship.

The most outstanding feature is the very striking fact that more than half of the A students have excellent vision. This correlation between vision and scholarship is more obvious among the A students, and to a lesser degree among the B students, than the correlation of vision and scholarship among the C and D students. In the latter two groups there is no such preponderance of one visual quality over others.

Therefore, we wonder if this excellent visual attribute, which has existed from early infancy and persists, is not in itself a factor through which wider experiences and wider general knowledge are obtained by the child and found the basis for his later scholarship ability. If such is the case, then the logical procedure would be to educate the public to the need for giving the child clear vision in his early years instead of waiting, as is now done, until he is half way through school. That would include educating the optometrists and oculists in methods of accurately fitting lenses to infants. Perhaps the second phase of this educational problem is more difficult than the first phase.

This summer we had an opportunity to make a survey of pre-school children, ages from one year to five, the results of which will be published in this journal soon. It is quite in line with the findings shown in these tables that pre-school visual examinations commencing somewhere around the age of 18 months or two years are fully as important as examinations in the schools.

A preliminary correlation of the I. Q. ratings and vision and scholarship further emphasizes the point we have brought out as to the item of good vision forming a foundation for good scholarship. The correlations here shown are sufficient to warrant a further subclassification and a correlation of variables. Without doubt when this is done the rela-

tions between vision and scholarship will stand out more strongly. We have sufficient data to make some further subclassifications, but the sample is rather small and if we subdivide too much our subgroups will become so small they will lose their significance. In attempting to correlate single grades we found that in a single grade, or even in a single small school of 600 or 700 children, the correlations were very irregular, often contradictory and unreliable.

Having found by this small sample of 6,290 pupils and this gross classification that the visually handicapped child is scholastically handicapped, the next step is to collect a great deal more data from a great many more thousand children in order to definitely locate the types of refractive errors that most handicap student ability. In this we invite the cooperation of all optometrists in the United States and Canada who are interested in making school surveys in a manner that will give information valuable to the school authorities.

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THE INTERPRETATION AND COMPARISON OF CERTAIN NEAR POINT TESTS

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In the modern practice of refraction the findings of certain tests are of special importance. The final diagnosis is arrived at by analysis of the findings as to the matter of relationship of one set of findings to another. This is as it should be, for no optometrist should attempt to make an ocular diagnosis without giving due regard to the findings obtained in the various tests during the examination.

Extreme care must, however, be exercised in assigning specific diagnostic values to the findings of a certain single test and its comparison with the findings of another test, because a certain number of variables enter into the picture which make a definite diagnosis from such a comparison very questionable. This is due to the fact that the findings of a given test vary from day to day, from time to time when made during the same day and also vary with the change of the type of instrument used. There has been considerable discussion pro and con on this point, however, the statements made by the proponents as well as the opponents were merely hypothetical. There was no factual material available as far as the writer knows to support either side.

To obtain such facts the writer conducted an experiment using twenty-six subjects and made twenty-six tests on each subject. Three different types of tests were used to test the negative accommodation and three different types of tests were used to test the amplitude of accommodation. We shall record on the following pages the findings of only one subject, Miss M. B. These findings are typical of the entire group and will thus afford the reader an opportunity to get a bird's-eye view as to the findings one may expect to get if he were to examine his patient several times either on the same day or on different days.

It may be of interest to the reader to compare the clinical findings of Miss M. B. given in tables 1 to 6. In tables 1, 2 and 3 are recorded the findings of the negative accommodation as measured by three different methods, namely, (a) dynamic skiametry, (b) plus lens test, (c) cross cylinder test. In tables 4, 5 and 6 are recorded the amplitude of accommodation findings as measured by (a) minus lens, (b) near point reading card, (c) Duane Line, Comparison of Dynamic Skiametry Findings.

In table No. 1 are recorded the dynamic skiametry findings taken at 9:30 A. M. on six different days between April 5, 1936, and May 24 of the same year. It will be noted that from three to six tests were made during each experimental period. The tests were made separately for the right and left eye monocularly and binocularly. The minimum and maximum findings are recorded for each test. The minimum in table 1 represents the neutralization point in the dynamic skiametry test. The maximum represents the point of reversal. It will be observed that the first set of monocular findings for the right and left eye on April 5 are 2.75 D. S. (Mi) minimum and 3.00 D. S. the (Ma) maximum and the last set of monocular findings for the right eye 3.75 D. S. the minimum and 4.00 D. S. the maximum, or a difference of 1.00 D. S. Examining the figures given for the Mi and Ma for the left eye monocularly columns C and D as well as for the right and left eye binocularly, considerable differences are found between the tests made on different days as well as those between made on the same day.

Comparison of Plus Lens Test

In table No. 2 are recorded the findings of the negative accommodation when plus lenses and reading card tests are used, or the plus lens blur point technique. These tests were made on the same day and at the same sitting that the dynamic skiametry tests were made. This is equally true of all other tests which are discussed in the following pages. The monocular right eye Mi (column A) values show a variation in the findings of about 1.25 D. S., that is, the lowest value in that column is 0.75 D. S. and the highest is 2.00 D. S. In column E the lowest value is 0.50 D. S., the highest 2.50 D. S., or a difference of 2.00 D. S. Extreme caution should be exercised if the findings of these tests are to be used in comparison with others for definite diagnostic purposes.

Comparison of Cross Cylinder Tests

In table No. 3 are recorded the Cross Cylinder Test findings.

Under the column Mi (minimum) is recorded the amount of sphere required to equalize the horizontal and vertical lines. Under the column Ma (maximum) is recorded the amount of sphere that will cause the vertical lines to appear the darkest.

In column A the findings range from 0.00 D. S. to 50 D. S. In column B they range from 0.50 D. S. to 1.50 D. S. Column C gives consistently a value of 0.00 D. S. and column E with but a few exceptions gives similar value. These findings are of a subject who gives consistently in the dynamic skiametry values ranging from 0.50 D. S. to 2.00 D. S. or a difference of 1.50 D.S. It should be emphasized here that while the cross cylinder test for the minimum in columns A, C and E gives a value of 0.00 D. S. with but few exceptions where the highest value is given as 0.50 D. S., this same subject gives a higher value for dynamic skiametry as shown in table 1, column A, 3.50 D. S.; column C, 3.75 D. S., and column E, 2.50 D. S. It can thus be seen from the

TABLE NO. 1

Negative Accommodation

Dynamic Skiametry

Name: Miss M. B.

		Monocular				Binocular			
		R.E.	R.E.	L.E.	L.E.	R.E.	R.E.	L.E.	L.E.
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F	G	H
4/ 5/33	9:30	2.75	3.00	3.25	3.50	2.00	2.25	2.25	2.50
"	"	2.75	3.00	3.25	3.50	2.00	2.25	2.25	2.50
"	"	3.00	3.25	3.50	3.50	2.00	2.25	2.25	2.50
4/12/33	"	3.00	3.25	3.50	3.75	2.00	2.25	2.25	2.50
"	"	3.00	3.25	3.25	3.75	2.00	2.25	2.25	2.75
"	"	3.00	3.25	3.50	3.75	2.00	2.25	2.50	2.75
"	"	3.00	3.50	3.25	3.75	2.00	2.25	2.25	2.75
4/19/33	"	3.50	3.75	3.75	4.00	2.50	2.75	2.25	2.75
"	"	3.50	3.75	3.75	4.00	2.50	2.75	2.25	2.50
"	"	3.50	3.75	3.75	4.00	2.50	2.75	2.25	2.50
"	"	3.75	4.00	3.75	4.00	2.50	2.75	2.50	2.75
5/10/33	"	3.75	4.00	3.75	4.00	2.25	2.50	2.50	2.75
"	"	3.75	4.00	3.75	4.00	2.25	2.50	2.50	2.75
"	"	3.75	4.00	3.75	4.00	2.25	2.50	2.50	2.75
"	"	3.50	3.75	3.50	3.75	2.00	2.25	2.50	2.75
"	"	3.50	3.75	3.50	3.75	2.25	2.50	2.50	2.75
"	"	3.25	3.50	3.25	3.50	2.25	2.50	2.25	2.25
5/17/33	"	3.50	3.75	3.50	3.75	2.25	2.50	2.50	2.75
"	"	3.50	3.75	3.50	3.75	2.25	2.50	2.50	2.75
"	"	3.50	3.75	3.25	3.75	2.25	2.50	2.75	3.00
"	"	3.00	3.25	3.75	4.00	2.25	2.50	2.75	3.00
"	"	3.00	3.25	3.75	4.00	2.25	2.50	2.75	3.00
"	"	3.00	3.25	3.75	4.00	2.50	2.75	2.75	3.00
5/24/33	"	3.25	3.50	3.75	4.00	2.25	2.50	2.75	3.00
"	"	3.25	3.50	3.75	4.00	2.25	2.50	2.75	3.00
"	"	3.00	3.50	3.75	4.00	2.25	2.50	2.75	3.00

TABLE NO. 2

Negative Accommodation

Plus Lenses and Reading Card

Name: Miss M. B.

		Monocular				Binocular			
		R.E.	R.E.	L.E.	L.E.	R.E.	R.E.	L.E.	L.E.
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F	G	H
4 ' 5/33	9:30	1.50	3.75	2.00	4.00	1.00	3.00	1.75	3.75
"	"	1.50	3.50	2.25	4.25	1.50	3.50	1.00	4.25
"	"	1.50	3.50	3.00	4.00	1.00	3.75	2.00	4.00
4/12/33	"	2.00	3.25	1.50	4.00	1.25	3.00	1.00	3.25
"	"	1.50	3.75	2.25	4.00	1.00	3.75	2.00	4.25
"	"	1.25	3.50	3.00	4.00	2.00	3.50	2.00	3.75
"	"	2.25	3.75	2.25	3.75	2.25	3.50	2.00	3.75
4/19/33	"	1.50	3.75	1.00	3.75	2.50	3.75	2.00	4.00
"	"	1.25	3.75	1.00	3.75	2.50	3.75	2.50	4.25
"	"	1.50	4.00	1.00	3.75	2.50	3.75	2.25	4.00
"	"	1.25	3.50	1.25	4.00	1.50	4.00	2.75	4.25
5/10/33	"	1.00	3.75	1.00	4.50	1.00	4.75	1.00	4.50
"	"	1.25	4.25	1.50	4.50	1.50	4.75	1.00	4.50
"	"	1.00	4.00	1.50	4.50	1.25	4.25	1.00	4.50
"	"	.75	4.50	1.25	4.50	1.00	4.50	.75	4.50
"	"	1.00	4.25	1.00	4.75	1.00	4.25	1.00	4.50
"	"	1.25	4.25	1.25	4.75	1.25	4.75	1.00	4.50
5/17/33	"	.75	4.50	1.50	4.75	.75	4.00	1.00	4.75
"	"	.75	4.75	2.00	5.00	.75	3.75	1.50	5.00
"	"	1.00	4.50	2.00	5.00	1.00	4.50	1.00	5.00
"	"	1.00	4.75	1.50	4.75	1.00	4.25	1.00	4.75
"	"	1.50	5.00	1.75	4.75	.50	5.00	1.00	4.50
"	"	1.50	4.25	2.50	5.00	1.50	4.25	1.00	4.75
5/24/33	"	1.25	4.50	1.00	4.75	1.25	4.50	1.75	5.00
"	"	1.00	4.25	1.25	4.75	1.00	4.75	1.25	4.75
"	"	1.00	4.25	1.50	4.75	1.25	4.75	1.00	4.75

TABLE NO. 3

Negative Accommodation

Cross Cylinder Test

Name: Miss M. B.

		Monocular				Binocular			
		R.E.	R.E.	L.E.	L.E.	R.E.	R.E.	L.E.	L.E.
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F	G	H
4/ 5/33	9:30	0.00	0.75	0.00	0.75	0.00	1.00	0.00	0.50
"	"	0.00	0.75	0.00	0.50	0.00	0.50	0.00	0.75
"	"	0.00	0.50	0.00	0.25	0.00	1.00	0.00	0.50
4/12/33	"	0.00	0.75	0.00	0.50	0.00	0.25	0.25	0.50
"	"	0.00	0.75	0.00	0.75	0.00	0.50	0.25	0.50
"	"	0.00	0.75	0.00	0.75	0.00	0.25	0.50	0.75
"	"	0.00	0.50	0.00	0.50	0.00	1.00	0.00	0.50
4/19/33	"	0.00	0.50	0.00	1.25	0.00	0.50	0.00	0.50
"	"	0.00	0.75	0.00	1.50	0.00	0.50	0.00	0.50
"	"	0.00	1.00	0.00	1.50	0.00	0.50	0.00	0.50
"	"	0.00	0.50	0.00	1.25	0.00	0.50	0.00	0.75
5/10/33	"	0.50	1.00	0.00	0.75	0.50	0.75	0.50	1.00
"	"	0.50	0.75	0.00	0.75	0.25	0.50	0.50	1.00
"	"	0.50	0.75	0.00	0.75	0.25	0.75	0.50	0.75
"	"	0.50	0.75	0.00	0.75	0.25	0.75	0.25	0.50
"	"	0.25	0.75	0.00	0.75	0.75	1.25	0.50	0.75
"	"	0.50	0.75	0.00	0.50	0.75	1.25	0.25	0.75
5/17/33	"	0.00	1.00	0.00	1.00	0.00	1.25	0.00	0.75
"	"	0.00	0.75	0.00	0.50	0.00	1.75	0.25	1.00
"	"	0.25	1.50	0.00	1.50	0.00	2.00	0.00	1.50
"	"	0.25	1.00	0.00	1.50	0.00	1.75	0.00	1.75
"	"	0.25	1.50	0.00	1.50	0.00	2.00	0.50	1.75
"	"	0.25	1.50	0.00	1.50	0.00	2.25	0.50	2.25
5/24/33	"	0.00	0.50	0.00	1.75	0.25	1.25	0.50	2.50
"	"	0.00	0.75	0.00	1.75	0.25	1.25	1.25	2.25
"	"	0.00	0.75	0.00	2.00	0.00	1.25	0.00	3.00

raw data presented here that the cross cylinder findings bear no relationship to the tests recorded in tables 1 and 2.

Comparison of Amplitude of Accommodation (Reading Card) Test

In table 4 are recorded the amplitude of accommodation values obtained by using the ordinary reading card. The card was moved toward the subject, the point at which the smallest size type began to blur. This was recorded at the Mi (minimum) and the point where the type blurred out completely was taken as the Ma (maximum). In column A it will be seen that the values range from the lowest, 3.6 D. S., to the highest, 10.00 D. S., a difference of 6.4 D. S. Similar variation in range will be found in columns B, C, D, E and F. It will be noted that on May 10, 1933, six consecutive tests were made, the lowest value being 4.30 D. S. and the highest 6.20 D. S., or a difference of about 2.00 D. S. Here again one would be at a loss to know as to what set of findings to use for comparison purposes in arriving at a proper diagnosis.

In table No. 5 are recorded the findings of the amplitude of accommodation using the Duane test line which is similar in principal to the reading card test, the findings of which are recorded in table No. 4. Indeed the values recorded in tables 4 and 5 are very similar, and are just as variable.

In table No. 6 are recorded the amplitude of accommodation obtained by using the minus lens test. Here again the reader can readily observe the difference in the findings from day to day and the variation in the findings from different tests on the same day. The intelligent reader will readily observe the difference in the findings recorded in tables Nos. 4 and 6. Here the amplitude of accommodation was tested of the same person with two different methods and the differences are indeed very striking. For instance, in table 4, column A, the lowest value is 3.30 D. S., and the highest 10.00 D. S., while in table No. 6, column A, the lowest value is 1.00 D. S. and the highest 5.00 D. S. We can thus see that the low findings in table 4, column A, are more than three times as great as is the lowest value in table No. 6, column A. And the highest value in the first instance is twice as great as the highest value in the second instance.

The variation in the near point findings from time to time must not be overlooked when an attempt is made to use these findings for diagnostic purposes. For example, if we consider the figures given in the preceding paragraph, an amplitude of accommodation of 5.00 D. elicited with one test may be considered low, while the 10.00 D. obtained with the other test may be considered high. Again, if we consider the minimum, which is the first point where the print begins to blur, we obtain with one test 3.30 and with the other 1.0 D., and if we take the maximum we find with one test it is 10.0 D. and with the other we find the amplitude of accommodation to be only 5.0 D. The question which presents itself to the critical observer is what set of findings are to be used in the diagnostic procedure? Shall we use the minimum or maximum

TABLE NO. 4

Amplitude of Accommodation

Reading Card

Name: Miss M. B.

		Monocular				Binocular	
		R.E.		L.E.		O.U.	
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F
4/ 5/33	9:30	9.10	14.30	10.00	15.00	10.00	14.30
"	"	10.00	14.30	11.10	15.50	10.00	16.60
"	"	8.10	12.50	11.10	14.50	10.00	16.60
4/12/33	"	5.00	15.00	7.10	14.30	5.90	18.00
"	"	5.90	16.00	8.30	16.00	7.90	20.00
"	"	5.20	16.00	7.10	14.30	8.30	19.00
"	"	6.60	16.60	6.20	14.30	7.70	19.00
4/19/33	"	4.80	16.60	5.90	14.30	6.20	20.00
"	"	5.00	16.60	5.20	14.30	6.20	20.00
"	"	6.20	20.00	4.80	16.60	5.00	20.00
"	"	4.80	20.00	5.50	16.60	5.50	20.00
5/10/33	"	6.20	20.00	8.30	20.00	5.00	20.00
"	"	6.20	20.00	5.90	16.60	5.00	16.60
"	"	5.50	20.00	5.90	16.60	5.00	20.00
"	"	4.50	16.60	4.50	14.30	4.10	16.60
"	"	4.50	16.60	4.50	14.30	4.50	16.60
"	"	4.30	14.30	5.90	14.30	4.50	20.00
5/17/33	"	4.50	14.30	4.10	16.30	4.30	20.00
"	"	4.50	14.30	4.50	14.30	4.80	20.00
"	"	4.30	14.30	4.10	16.60	5.50	20.00
"	"	3.80	12.50	4.50	16.60	4.30	16.60
"	"	3.60	16.60	4.50	20.00	4.10	16.60
"	"	4.30	14.30	4.00	20.00	5.50	16.60
5/24/33	"	4.50	14.30	4.50	20.00	4.50	20.00
"	"	5.00	16.60	4.50	16.60	4.50	16.60
"	"	4.30	12.50	4.30	16.60	4.30	16.60

TABLE NO. 5

Amplitude of Accommodation

Duane Line Test

Name: Miss M. B.

		Monocular				Binocular	
		R.E.		L.E.		O.U.	
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F
4/ 5/33	9:30	11.10	16.60	12.50	22.00	10.00	18.00
"	"	7.70	20.00	9.10	22.00	11.10	16.60
"	"	10.00	20.00	10.00	25.00	10.00	14.30
4/12/33	"	4.10	12.50	11.10	20.00	6.60	16.60
"	"	4.50	14.30	12.50	20.00	10.00	20.00
"	"	8.30	16.60	14.30	25.00	6.20	20.00
"	"	4.10	12.50	12.50	22.00	9.10	18.00
4/19/33	"	5.20	16.60	10.00	22.00	6.60	20.00
"	"	5.00	14.30	7.10	25.00	5.20	16.60
"	"	5.90	20.00	8.30	20.00	4.50	20.00
"	"	4.50	14.30	7.70	20.00	4.50	25.00
5/10/33	"	4.80	20.00	7.70	25.00	6.60	25.00
"	"	5.50	16.60	5.20	25.00	3.80	16.60
"	"	7.10	25.00	5.00	25.00	4.30	25.00
"	"	4.50	20.00	5.50	25.00	5.20	25.00
"	"	4.50	16.60	5.90	25.00	5.00	25.00
"	"	5.50	25.00	7.70	25.00	4.50	25.00
5/17/33	"	4.50	25.00	7.70	25.00	4.50	25.00
"	"	4.50	25.00	5.50	25.00	4.30	25.00
"	"	5.50	25.00	5.00	25.00	4.30	25.00
"	"	4.00	25.00	5.50	25.00	5.90	25.00
"	"	4.50	25.00	5.50	25.00	5.20	25.00
"	"	4.10	25.00	4.50	25.00	4.50	25.00
5/24/33	"	4.50	25.00	6.20	25.00	5.20	25.00
"	"	10.00	25.00	4.80	25.00	5.20	25.00
"	"	5.90	25.00	5.00	25.00	4.50	25.00

TABLE NO. 6

Amplitude of Accommodation

Minus Lens Test

Name: Miss M. B.

		Monocular				Binocular			
		R.E.	R.E.	L.E.	L.E.	R.E.	R.E.	L.E.	L.E.
Date	A.M.	Mi	Ma	Mi	Ma	Mi	Ma	Mi	Ma
		A	B	C	D	E	F	G	H
4/ 5/33	9:30	1.00	6.00	1.25	5.75	1.00	6.50	1.50	7.00
"	"	3.50	5.75	1.75	6.75	1.25	6.75	2.00	6.75
"	"	2.25	5.50	2.00	6.00	1.50	7.00	2.50	7.00
4/12/33	"	3.00	7.00	4.25	7.50	3.00	7.00	4.00	7.00
"	"	5.00	7.25	4.50	7.50	2.25	7.00	2.25	6.50
"	"	4.50	7.00	4.50	7.50	2.75	6.50	2.25	6.50
"	"	4.75	7.50	4.50	7.00	2.50	6.50	2.75	7.00
4/19/33	"	1.25	6.50	1.50	7.00	1.00	4.00	1.25	5.50
"	"	1.75	6.75	1.75	6.50	1.25	5.00	1.25	6.00
"	"	1.75	6.50	1.25	7.75	1.00	5.50	1.25	6.75
"	"	1.00	7.00	1.00	7.50	1.25	5.50	1.50	6.25
5/10/33	"	1.00	6.50	1.25	6.25	1.00	5.75	1.00	6.00
"	"	1.25	6.50	1.50	5.50	1.00	5.25	1.50	6.25
"	"	1.00	6.00	2.00	5.75	1.50	5.50	1.25	6.00
"	"	1.25	6.00	1.25	6.25	2.00	5.75	1.00	6.50
"	"	1.00	6.00	1.75	5.75	1.50	5.75	2.00	6.00
"	"	1.50	6.75	1.50	6.00	1.00	6.00	1.75	6.25
5/17/33	"	2.75	7.00	3.00	7.50	3.00	7.00	3.00	6.75
"	"	2.75	7.00	3.00	7.00	3.50	7.00	3.00	7.00
"	"	2.75	7.00	3.00	6.50	3.50	7.00	3.00	6.50
"	"	2.75	7.50	3.00	7.50	3.00	6.50	3.25	6.50
"	"	2.50	7.50	3.00	7.25	2.75	7.00	3.00	6.00
"	"	2.50	7.00	3.00	7.25	2.50	7.00	3.50	7.00
5/24/33	"	2.00	6.50	2.00	7.50	1.00	6.00	1.75	7.50
"	"	1.75	7.25	2.00	7.25	1.00	6.25	1.50	7.50
"	"	2.25	8.00	1.75	7.75	1.00	6.50	1.00	7.25

blur point findings and if one decides to use for example the maximum, then he is at once confronted with the very next question and that is this, shall we use the findings obtained by using the minus lens test, which was 5.0 D. or shall we use the values obtained by bringing the reading card close to the eyes until the blur out point is reached, which was 10 D. in the above example.

From a close study of the raw data recorded in tables 1 to 6 one can readily see the difficulties we run into in trying to use some of these findings for analytical and diagnostic purposes. As stated earlier in this discussion we merely recorded the findings of various near point findings of one subject, in order that we may get a bird's-eye view of the values as recorded in the raw data. One can not draw any conclusions from the above data as to the reliability and variability of the different near point tests and about the findings obtained with these tests. This subject will be treated more fully in the next two articles giving a complete statistical analysis of the findings and of the reliability and variability of the different near point tests that are commonly used clinically by most refractionists.

Summary

1. The raw data obtained by testing one subject several times a day on several different days, using various near point tests is recorded.

2. It is pointed out that there is a considerable variation in the findings between the minimum and maximum when the same test is used and that there is also great variation when two different tests are used.

3. The disagreement in the findings is pointed out and the question is raised, can these variable findings be properly used for analytical and diagnostic purposes with any degree of accuracy.

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FACTUAL INFORMATION ON THE VALUE OF ORTHOPTIC TREATMENT WORK AND PHYSICAL THERAPY IN OPTOMETRICAL PROCEDURES

No matter what view is taken of the matter, the success or failure of any form of treatment technique or therapeutic agent in optometry is gauged by its action on living patients. The real value of the treatment to the patient is not to be measured by the opinions of the educator who suggests the use of the therapy nor by the optometrist who, at his suggestion, puts it into practice, but rather by the clinical facts he can demonstrate after the treatments are finished. It is often observed in optometry that any new form of treatment which may be suggested, no matter how weak a theoretical foundation it may have, is regarded as valuable by some groups of optometrists and some individual patients who have been talked into trying it. This, of course, means that in both the patient and the optometrist there is working a psychologic factor of significant proportions. Such success as may be obtained in this manner is often and obviously therefore a manifestation of psychotherapy, subconscious in nature, rather than of actual physiologic activity as a result

of the treatment techniques employed. As Kurtz[1] has said, the capacity for management of the psyche should be in the armamentarium of all optometrists, in addition to having at his command all of those optometric and orthoptic and physical therapeutic agents that can be proved to be of real value in the optometric case. It is my purpose in this paper to explain how the various optometric devices and methods of orthoptic treatment work and ocular physical therapeutic agents may be rationally evaluated. This evaluation must take into consideration the investigator, the subject matter to be investigated and the manner of conducting the investigation.

The successful investigator in this field is not merely an optometrist or a person. He must be an optometrist who by experience, training, imagination, initiative, controlled curiosity and intellectual honesty is qualified to undertake an objective examination of the subject at hand, without consulting preconceived ideas or prejudice. He must attack the given problem deliberately, with a clear outline of a program before him, based on a well conceived hypothesis, and at the same time be thoroughly familiar with the work of other optometrists along the same and similar lines. This plan excludes at once the quack and the charlatan as well as the man with a poor background of the basic sciences. More important, too, it excludes that type of optometric practitioner who commonly reports on the value of a form of orthoptic treatment or ocular physical agent, without having an adequate knowledge of the method or substance of the treatment therapy employed. It also excludes the type of refractionist who so frequently reports cases without supplying adequate proof, of the accuracy of his diagnosis of the condition claimed to have been treated, and without affording a scientifically established demonstration of the value and accuracy of his conclusions by comparison with control tests wisely chosen and properly performed.

Before going further in this discussion, it might be well to define again the optometrist's position in the matter of using various physical agents in his work on patients coming to him for relief from symptoms of visual disorders and functional innervational disturbances as they affect the eyes. Last year, the writer, in then discussing this subject[2], said: Perhaps it would be well to define the term physical therapy. Physical therapy is a term employed to describe the treatment of various disorders of the human system by physical and mechanical means. It comprises the use of physical, chemical and other properties of heat, light, electricity, exercise and massage. As this applies to optometry it is the beneficial application of these agents, in those ocular cases where there are certain definite indications for the use of one or more of these physical agents, in the correction of the existing abnormality. An optometrist using physical therapy should be a graduate who has had special training and who has acquired skill in the therapeutic use of these methods.

This statement brought forth some protest from optometrists who, while themselves daily performing many acts with physical agents, in the routine prescribing of ophthalmic lenses for their patients, felt that

the use of some of the other agents mentioned by the writer were somewhat outside the field of optometric practice as they cared to practice it, and interpret it. This of course was their privilege, and the writer refused to enter into what then seemed to be a fruitless discussion of the matter, feeling then, as he does now, that the underlying thought of the optometric profession will be gradually changed on this matter as optometric educational qualifications be further raised by our colleges. This last hope is now well along towards fulfillment, as the writer now understands that no optometric college will be recognized by the State Boards of Optometry after 1938, which does not give at least a full four year college course to its students. The writer was also criticised last year for his definition of the term physical therapy and several persons challenged him to produce some other authority in one of the other professions who had made the same interpretations which he did in this matter. To any one who had made any sort of a study of the subject of physical agents, the matter was obvious, yet at the moment I could not place my hand on the writings of any non-optometric writer who covered the subject in that particular manner and therefore at that time I was unable to comply with their request, yet within the past few months new material has come to hand which now enables me to satisfy those critics who felt my definition, given in 1935, was unsatisfactory.

I therefore now refer to the writings of Karsner and Goldblatt[3], medical writers, who say: "Physical therapy employs a variety of physical agents: massage, therapeutic exercise, water, air, radiations (heat, light, ultra-violet, X-rays, radium), vibrations (mechanical, sound), and electricity of various forms." These men are recognized experts in the field of medical physical therapy, and are scientists of some repute. Their definition coming as it does a year after the one referred to by the writer, emphasizes the position taken by the writer in 1935 and for a considerable period of time before that, as I will shortly show. In the meantime it is also well to consider the variety of routine ways the optometrist daily enters the field of physical agents and physical therapy, using the definition of Karsner and Goldblatt just referred to. For example, take therapeutic exercise. Every form of ocular orthoptic treatment is included in this phase of the work of physical therapy, and as I have already said, the optometrists' constant use of lenses, which in many various ways affect light and its physiological action on the tissues and nerve centers controlling vision, therefore falling into the same category. That this view of mine is not a new one, let me briefly quote from some of my writings as far back as 1929, when, in writing on this same subject, I said[4]: It has ofttimes been said that a lens is not a "pill," yet it is without a doubt a physical agent, when prescribed to correct a visual defect, and the optometrist who prescribes it is therefore practicing a form of physical therapy, the effects of which have an unquestioned far reaching effect on the entire nervous system. I have just said that in prescribing an ophthalmic lens the optometrist performs an act in physical therapy. This is true in the broad sense of the term just as much as though

he had applied hot packs to the eyes or had used a form of ocular massage to increase the circulation of blood, to these organs. Physical therapy, it must be understood, includes any technic wherein a physical element or remedy is used to stimulate, repress or in any way change normal or abnormal physiological action. The foregoing being true, it is therefore obvious that optometrists as a whole are unquestionably one of the largest professional groups in existence today using a form of physical therapy and it is not surprising therefore to find this group gradually supplementing its hitherto purely optometric forms of physical therapy with other types of physical therapy which seemingly aid in correcting certain cases such as amblyopia and muscular imbalance, etc. This indicates that in the routine work of the optometrist, physical therapy plays a close and valuable part, and therefore every method which can successfully be used, should be studied and applied to those refractive and neurological cases which now come to us for relief.

In orthoptic treatment work or in a case wherein some specific form of ocular physical therapy should be employed, it is not uncommon to find that the condition to be treated is not a well defined visual abnormality with an established cause, a characteristic course of development and one in which a prognosis can be made with some degree of certainty. When this is true the symptomatic variations in manifestations to the patient are so wide, that the investigation of the suggested therapy to be employed, must cover an extremely large number of cases, including both treated cases and non-treated cases used as controls. This is true irrespective of what form of orthoptic technique or physical agent is to be employed. This is true, because in most cases requiring these therapeutic aids to normal vision the cases are those in which the disturbance is neurological in character.

For example, compare the treatment of some of the vague imbalances of the extra-ocular muscles showing an emmetropia and no outward signs of disorder and having painful vision as the chief symptom, with a case in which one finds that all that seems necessary is the correction of a hyperopic condition, similarly attended by painful vision and having an orthophoria. In the former case there is no objective way of determining improvement, and it is difficult to know whether whatever improvement that is reported, is due to the physical or psychic effect of the treatment or simply a natural variation of the symptoms. In the latter case the changes following the prescribing of certain types of corrections can be determined objectively by various refractive methods and a better evaluation of the effects of the corrective measures can therefore be made.

As I have said, physical therapy employs a variety of physical agents comprising the use of physical, chemical and other properties of heat, light, electricity and exercise. This would of course include the use of ophthalmic lenses and the use of prismatic lenses in optometrical orthoptic treatment work. All applied science, of which optometry is a part, is built on a groundwork of pure science, and in the same manner

all of the appliances of use and of value, in physical therapy have a background of knowledge in pure physics. In addition to this, every rational therapeutic effort has at its call, a certain volume of knowledge of the physiological effects of the agents employed. Thus it is known that the physical agents just enumerated may, and do, cause certain physiologic reactions when used on and before the eye in certain well defined ways. These actions may be either good or bad, depending on the manner in which they have been applied.

The information available about these effects in orthoptic treatment work, and in ocular physical therapy, is much less than is true of a number of the more purely physical substances such as lenses. For the furtherance of orthoptic treatment work and ocular physical therapy it is necessary that a much larger bulk of exact factual information be built up, than is now available.

In optometry, these basic facts are to be furnished chiefly by the anatomist, the biologist, the physiologist and the biophysicist. Funds must be made available so that these potential sources of information may be activated to a further and more intensive study of the fundamental action of the various physical agents as they relate to the eye. For example, as Sheard[5] has shown us, that within certain ranges of wavelength, ultra-violet radiations activates ergosterol in the living plant and animal, and also in the test tube, so that an active antirachitic substance is formed. The exact process that takes place is not as yet clearly established. This of course is non-optometric but given merely as an example of the important part the scientist plays in developing therapeutic fields. An optometric example would be the type of work done by the English ophthalmologist, Duke-Elder[6], in his investigations, in the field of the effect of radiant energy on the cell structure of the crystalline lens.

In the field of ocular physical therapy, and orthoptic treatment work, it can only be said that there is a rather strong presumption that certain ocular biophysical and biochemical reactions can be obtained, as nothing as yet can be proved. Indications are there that much valuable optometric work can be done, yet the underlying scientific investigations must as yet be made in this field, as many of our teachings and our techniques are as yet supported by little else but the most fragmentary clinical evidence. Evidence of little or no value because of its source and the manner in which the clinical work was done.

This general statement does not mean, for example, that specific visible light therapy may not have beneficial effects in certain ocular cases, nor does it mean that they have no potentialities of harm. It does mean, however, that precise information as to these possibilities, has not yet been obtained. The problems still to be solved in the fields of practice with these visible rays, as well as in the field of ocular electrotherapy, and also in the field of orthoptic treatment work, evidence a need for further researches in the field of the physics and the radiations themselves. Also additional research on the physiological actions of the rays

on the tissues of the eye, as well as a study of muscular fatigue of the extra-ocular muscles in optometric practice. What has been said about specific visible light therapy, is applicable also not only to the effects of electro-magnetic currents on the tissues of the eye, but also to the action of the invisible rays of the spectrum on these same tissues. The problems are innumerable. The physiologic effects of orthoptic prismatic stimulation, are but imperfectly known, and this form of treatment, excellent though it be, is largely empirical and either entirely dependent on or intimately bound up with the effects of ocular exercise and fatigue. The same is true of stereoscopic treatments. Our knowledge of the exact effects of this form of fusion stimulation or training is also quite incomplete. Fortunately, most of these optometric agents are not dangerous and may be employed in optometric practice without risk to the subjects undergoing the treatments.

The study of the effects of ocular physical therapy and orthoptic treatments is of necessity entirely an experiment conducted upon human beings. This experiment must be set up with all the deliberation and forethought of experiments in any line of scientific work. The evaluation of the effects of various optometric treatment techniques in the treatment of certain visual and neurological disorders is difficult, because the results cannot be always determined accurately by objective means. To be sure, in every case this must be attempted, but in many of these neurological cases with their ill-defined ailments and their lack of objective criteria, the determination of a diagnosis and the study of the effect of the treatments are difficult to achieve. In these cases the problem frequently resolves itself into trying to decide just what, or which one of several, factors, was responsible for whatever change took place during the period under which the case was being treated. And as has been mentioned before, there is in this form of human experimentation the psychic factor, which may or may not enter into the work.

Therefore in optometry, from an experimental clinical standpoint all that the optometrist himself can do is to use the statistical method of evaluating results. This of course takes time, but the end results, when carefully followed, produce material of value on which additional progress can be made.

In the statistical method of approach to a problem of this kind one of the popular procedures, is that every alternate patient does not receive the treatment. Owing to many individual variations and to the psychic factors already mentioned, this form of a study requires an extremely large number of observations, and these orthoptic cases must of necessity be followed for a long period of months before any lasting judgments of value could be formed. In making observations with the statistical method the number of observations must be greatly multiplied so as to decrease the factor of error which in any diagnostic field is necessarily large.

This error can be largely eliminated by two optometrists working together in the following manner. Thus, one optometrist as treatment

technician, gives the treatments, and the second optometrist makes periodic ocular examinations of the same patients without knowledge as to which have, and which have not, had any specific treatment therapy under observation. Strange as it may seem, this critical approach to the statistical method is rarely practiced on patients, but is the common laboratory method of handling experiments, carried on, on animals. In viewing this matter as a whole one is more or less forced to the conclusion that this latter method is the only clinical method which is very likely to lead to correct and logical conclusions.

The main essential of any experiment, in ocular orthoptic treatment work, is that observations with any one particular form of treatment therapy must be controlled and checked in a series of patients without using that particular treatment therapy on these control patients. The number of observations must be so large as to minimize some of the obvious disadvantages of random sampling. If the optometrist who conducts the treatment experiment is to know the nature of the method employed in each case, he must put his personal opinions into the background and make his observations as impartial and objective as is humanly possible. Little can be learned from objective tests on animals, so the final test of the effects and value of all of the various ocular therapeutic measures, designed to assist the optometrist in helping his patients, must be made on human beings. And this work must be done with extreme care or it is of little value. The art of optometry is an essential structure built on the firm foundation of ocular science and physical science and neither one part nor another can have any escape from the exact laws which govern all scientific evidence. As optometrists it is our duty to support movements within our societies which tend to develop additional research in this important field. Carel C. Koch.

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